



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

August 2, 2021

MEMORANDUM TO: Kevin Hsueh, Chief  
Radiation Protection and Consequence Branch  
Division of Risk Assessment  
Office of Nuclear Reactor Regulation

FROM: Luis Betancourt, Chief */RA/*  
Accident Analysis Branch  
Division of Systems Analysis  
Office of Nuclear Regulatory Research

SUBJECT: TRANSMITTAL OF DELIVERABLE FOR TASK 1 UNDER  
INFORMAL ASSISTANCE REQUEST NRR-2021-018,  
"VERIFICATION OF MACCS DOSE CONVERSION TO  
COMPUTE TOTAL EFFECTIVE DOSE EQUIVALENT"

By Informal Assistance Request (IAR) NRR-2021-018, "Verification of MACCS Dose Conversion to Compute Total Effective Dose Equivalent," dated June 14, 2021 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML21180A015), the Office of Nuclear Reactor Regulation (NRR) requested that the Office of Nuclear Regulatory Research (RES) undertake research to identify currently available MELCOR Accident Consequence Code System (MACCS) dose conversion factor (DCF) files that provide dose coefficients that may be used to compute the Total Effective Dose Equivalent (TEDE) dosimetric quantity. In particular, NRR requested RES to verify the values for the dose coefficients in these files against Federal Guidance Reports 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," and 12, "External Exposure to Radionuclides," and identify any discrepancies between these DCF files and the values provided in Federal Guidance Reports 11 and 12.

The request is being tracked by RES as User Need NRR-2021-018-IAR. RES responded to the request via work request form on June 29, 2021 (ADAMS Accession No. ML21180A015), agreeing to provide technical assistance. My staff provided the response to Task 1 of NRR-2021-018-IAR in the enclosed technical evaluation report.

CONTACT: Keith Compton, RES/DSA/AAB  
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As discussed with your staff, RES verified the MACCS DCFs file for consistency with the definition of TEDE in Title 10 of the *Code of Federal Regulations* § 20.1003<sup>1</sup>, "Definitions." For each of the 60 MACCS nuclides commonly used for light water reactor (LWR) consequence analyses, as well as their 11 short-lived progeny, RES evaluated the ratio of the effective dose coefficient values for cloudshine, groundshine, chronic inhalation, and ingestion to the effective dose equivalent dose coefficients provided in Federal Guidance Reports 11 or 12 (as supplied in FGRDCF databases derived from the Federal Guidance Reports 11 and 12 data library package distributed by the Radiation Shielding Information Center). In addition, RES evaluated the implicit progeny contributions as appropriate for the DCF file being examined. Finally, RES considered whether the DCF file used the appropriate chemical and physical forms recommended for light water reactor consequence analyses.

The results of our evaluation show that only the FGRDCF files *Dosd60.inp* and *Dosd825.inp* are consistent with Federal Guidance Reports 11 and 12. However, these DCF files are no longer supplied with WinMACCS but may be obtained on the MACCS download site as a part of the MACCS2 legacy software package. Dose coefficients from other DCF files are close for some isotopes but not as close for others. For example, considering the most current DCF file (FGR13GyEquiv\_RevA.inp), the external dose coefficients for iodine isotopes range from 0.93 to 1.03 of the FGR-12 values and the inhalation dose coefficients range from 0.83 to 1.27 of the FGR-11 values. However, the external dose coefficient for plutonium isotopes range from 0.72 to 0.89 of the FGR-12 values and the inhalation dose coefficients range from 0.13 to 0.21 of the FGR-11 values. Therefore, FGRDCF files should be used subject to certain caveats, the most salient of which are:

- Rb-88 is not included as an implicit progeny of Kr-88. Since Rb-88 is not one of the 60 nuclides commonly considered in LWR accident consequence analyses, the use of the FGRDCF files would underestimate Kr-88 doses by about 25% if Rb-88 was not included in the list of nuclides explicitly evaluated by MACCS.
- Te-129 is included as an implicit progeny of Te-129m but is also typically included as one of the 60 nuclides commonly evaluated using MACCS. Including Te-129 as implicit progeny may therefore overcount the dose contribution from Te-129m by a factor of about two.
- For the *Dosd825.inp* DCF file, the inhalation clearance class for isotopes of antimony is D instead of the recommended W. This results in an underestimate of the inhalation dose coefficient for Sb-127 by a factor of slightly over two and a slight (<10%) underestimation of the ingestion DCF for Sb-127 and the inhalation and ingestion dose coefficient for Sb-129.

The deliverable provided as an enclosure to this memorandum is responsive to the full scope of the work requested by your staff. This report was prepared in coordination with Elijah Dickson of the Radiation Protection and Consequence Branch in the Division of Risk Assessment at NRR. We look forward to our continued collaboration on different projects. Please do not hesitate to contact me or my staff with any questions.

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<sup>1</sup> See NRC public website at <https://www.nrc.gov/reading-rm/doc-collections/cfr/part020/part020-1003.html>.

K. Hsueh

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RES established an online quality survey to collect feedback from user offices on the usefulness of RES products and services. This survey can be found online at the [RES Quality Survey](#). I would appreciate the responsible manager or supervisor completing this short—about 5 minutes—survey within the next 10 working days to present your office's views of the delivered RES product.

Enclosure:  
Report for User Need  
NRR-2021-018

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